XMM-NEWTON EDUCATION AND PUBLIC OUTREACH PROGRAM

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We outline here the Education & Public Outreach (E/PO) program that accompanies the XMM-Newton mission post-launch. XMM-Newton is an ESA satellite with NASA participation through the US-based Guest Observer Facility. In 2003, the XMM-Newton E/PO program was transferred from UCSB, and consolidated with the other E/PO activities at Sonoma State University, under the direction of Prof. Lynn Cominsky.

The XMM-Newton E/PO program has the goal of producing both formal and informal educational materials for grades 4-12.

The formal education program currently includes: 1) participation in the SEU Educator Ambassadors (EA) program; 2) development with Gettysburg College of a new X-ray CLEA lab; and 3) development (with GLAST E/PO) of an educator's guide and poster about the science of supernovae. Informal education includes: 4) an outreach website with sections for teachers, students, and the general public that includes information about X-ray astronomy, the XMM-Newton mission, and its discoveries; 5) integration of XMM-Newton with the Global Telescope Network (GTN) in partnership with the AAVSO and the California Academy of Sciences; 6) creation of a planetarium show featuring XMM-Newton science for the Starlab portable dome; and 7) developing a partnership with NASA/JPL Space Place in order to develop bilingual educational materials and more effectively target underserved communities.

The flow down of XMM-Newton E/PO goals from the specific science goals for XMM-Newton is shown in Table 1. The alignment of XMM-Newton E/PO goals with the program components and the overall goals of the NASA Science Mission Directorate's Universe Division is also shown in this table.

1. XMM-Newton Mission E/PO Program Components

1.1 Educator Training

Beginning in 2004, XMM-Newton started supporting two Educator Ambassadors: Dr. Christine Royce (Pennsylvania) and Tom Estill (California) (see http://xmm.sonoma.edu/ambassadors/). Both EAs attended an intensive training at SSU in June 2002 (when they were funded by a different program) and again in July 2004. They learned about the science spanning all SEU missions (and the Beyond Einstein program), and received and tested materials created by many different SEU missions for use in future workshops. The 2004 EA training presentations are online at http://epo.sonoma.edu/ambassadors/training04/index.html. The next Educator Ambassador training will be held at Sonoma State University in July of 2006.

We continue to support the participation of these two EAs in local, regional, and national conferences. These highly-qualified master teachers have been very successful in distributing XMM-Newton educational materials to their peers. Although only four dissemination activities are required from each EA each year, they typically give at least six workshops. During 2004, the two XMM EAs did 15 teacher's workshops that reached 375 direct participants.

SSU team members participate annually in educator workshops, including NSTA and AAPT, and they staff an exhibit booth at regional educator conferences such as CSTA. In 2004, the exhibit booth was redesigned to include graphics for XMM-Newton as well as Swift and GLAST (the other two E/PO programs led by Sonoma State University.)

1.2 Contemporary Laboratory Experiences in Astronomy: X-rays from Supernovae

We are now in the external evaluation stage (by WestEd) of a computer-based laboratory exercise for high school and college students that analyzes simulated XMM-Newton spectra of the Cas A supernova remnant. Entitled “Dying Stars and the Birth of the Elements," this lab is being created with our partners at Project CLEA (Gettysburg College, under the direction of Prof. Larry Marschall) and in consultation with the XMM-GOF. Project CLEA was originally funded by NSF, and has 12 different laboratory modules already in distribution. By partnering with Project CLEA, we are able to leverage their extensive software development and dissemination channels. This product is aligned with National Science Education Standards for grades 9-12 (including Content standards A, B, D and E). See http://xmm.sonoma.edu/edu/clea to download the current version and installation instructions. The EAs will also test the laboratory, and revisions will continue through 2005, with final release expected in 2006.

1.3 Supernova Educator Unit: a GLAST Partnership

Development of a series of classroom activities featuring supernova science and an accompanying poster is now nearing completion at SSU. One activity involves the use of an Excel spreadsheet to model the decay rates of cobalt and nickel in order to recreate the supernova light curve; a second involves measuring the expansion rate of a supernova remnant, using real data to estimate its age; and a third incorporates an XMM-Newton discovery about a pulsar to engage the students in an exploration of magnetism and pulsar properties. This Educator Unit is being designed to be complementary to the CLEA lab described above, and will be aligned with the same National Standards. In order to ensure this alignment, the EAs will test these activities and revisions continuing through 2005, with final release expected in 2006, following extensive classroom testing and external evaluation by WestEd. Development of this Educator Unit is being shared with the GLAST E/PO program.

1.4 XMM-Newton E/PO website

The XMM-Newton E/PO website was transferred from UC Santa Barbara to SSU in 2003, and was entirely redone with a new look, updates to the science, and revamped mission and instrument pages' content. This website was evaluated by WestEd in 2003. We have also developed an image gallery to showcase the best results from the mission. The site is now completely Code 508 compliant and is continually maintained for new educational and science content. It can be viewed at: http://xmm.sonoma.edu, and the site is mirrored at: http://heasarc.gsfc.nasa.gov/docs/xmm_lc

1.5 XMM-Newton and the GTN

We are working on the integration of the XMM-Newton mission with the Global (formerly GLAST) Telescope Network (GTN). Along with the AAVSO and other partners, the GTN will be viewing polars and blazars. With the cooperation of the AAVSO, we have produced finding charts and standard sequences for a select group of both types of objects and are actively seeking further involvement of XMM scientists to coordinate multi-wavelength observations. The GTN

14-inch robotic telescope at the California Academy of Sciences' Pepperwood Natural Preserve is now online, and is available for use with GTN participants and Cal Academy attendees through (at least) 2008. See the list of target objects that are currently being monitored at http://gtn.sonoma.edu/participants/catalog/index.php.

1.6 Starlab Planetarium Show

We are partnering with Learning Technologies, Inc. (LTI; under the direction of Jane Sadler) to develop a planetarium show for portable planetaria known as Starlabs. Thousands of these small, low-cost planetaria are located across the country, many in schools, libraries, and small museums in rural areas. Draft versions in gif and PDF format of the X-ray sky image that have been sent to LTI for review for use in the cylinder are available for viewing at http://xmm.sonoma.edu/edu/planetarium/. We have also sent them the draft script/teacher's manual with short exercises to accompany the show. Additional field-testing and evaluation will occur after we incorporate feedback from LTI.

1.7 Space Place Partnership

Our plans for 2005-2008 include enlarging our reach to underserved communities by establishing a partnership with NASA's highly successful children's program Space Place (led by Nancy Leon at JPL). We are now developing an XMM-Newton-related activity featuring black holes that will reach many underserved students through their website in English (http://spaceplace.nasa.gov) and in Spanish (http://spaceplace.nasa.gov/espanol). The goal of this activity is to improve science literacy for grades 4-12.

In both 2006 and 2008, we plan to write several Space Place articles that will appear in their monthly column in 14 English and Spanish metropolitan daily newspapers, with possible selection for the ITEA's Technology and Children magazine and the newsletter of the National Association of Bilingual Educators. We will also write higher-level versions of these articles for distribution to the monthly newsletters of their network of over 200 amateur astronomy club newsletters nation-wide.

In 2007, we will develop one Club Space Place activity (middle school level) in order to reach underserved audiences, such as those in the inner cities and rural areas of the country. Space Place partners with the Boys and Girls Clubs of America (serving 3 million children, many of them minorities), the Young Women's Christian Association (770,000 girls), the 4-H clubs, and Civil Air Patrol.

All printed materials developed for XMM-Newton will be distributed through Space Place's museum and library partners. Through a network of 260 museums and libraries in 49 states across the United States, Space Place gives exposure to a potential audience of 27 million or more each year.

2. Evaluation, Assessment, Dissemination and Reporting

WestEd is responsible for the formal program evaluation and guidance of the XMM-Newton mission E/PO program. Led by Dr. Edward Britton, WestEd conducts independent formative and summative evaluations on a regular basis using professionally accepted qualitative and quantitative assessment tools such as questionnaires, telephone interviews, and focus groups. Evaluation of the training of teachers, classroom usage and student learning outcomes are the

ultimate goals of our assessment process. Assessment includes each individual part of the XMM-Newton E/PO program, as well as measuring the overall effectiveness of the parts working together to quantify the true impact of our efforts in the education and general public communities. The results of the evaluations are submitted as each review is completed to E/PO Lead Cominsky, who in turn conveys the reports to GSFC Project Scientist Nicholas White and to HQ on a regular basis. See Table 2 for details of the past, current and future evaluation schedule.

NASA E/PO programs are required to submit records of all activities to EDCATS, and to enter all downloadable educational materials into the SSERD. XMM-Newton E/PO activities have been reported for the past two years, and summaries have appeared in the NASA OSS E/PO annual report. We have also entered released XMM-Newton products into the SSERD.

Year-end reports are compiled by Cominsky and submitted to GSFC Director of the Exploration of the Universe Division Dr. Nicholas White and to HQ. These reports include the results of all external evaluations, as well as the EDCATS totals for all XMM-Newton E/PO activities.

3. XMM-Newton E/PO Management

The organization of the XMM-Newton E/PO effort is shown in Figure 1. The GSFC Director of the Exploration of the Universe Division Dr. Nicholas White has full responsibility for overseeing the Guest Observer Facility, including E/PO activities. Dr. White is fully committed to E/PO and 1) provides oversight on the E/PO program to ensure that all E/PO products are scientifically accurate and technically correct; and 2) ensures that all E/PO activities are consistent with the scientific and technological goals of the mission.

At Sonoma State University, E/PO lead Prof. Lynn Cominsky oversees the E/PO program under the guidance of the GSFC Project Scientist. Prof. Cominsky 1) provides a focused direction for the SSU team; 2) coordinates all E/PO activities with all participants, including the GOF staff, SSU team, and all E/PO partners, the Science Mission Directorate E/PO, and the NASA Office of Education and the external evaluators at WestEd; 3) ensures that the mission science will be combined with innovative learning ideas and aligned with national science and mathematics standards; and 4) provides lead work direction to the Educational Resource Director (Dr. Phil Plait) and the Program Manager (Sarah Silva).

The E/PO Program Manager Sarah Silva 1) manages the XMM-Newton E/PO program on a daily basis, coordinating all programs and activities under the direction of the E/PO lead. She 1) supervises the other SSU E/PO staff including the Instructional Technology Expert, the Scientific Illustrator and the Project and Student Assistants; 2) is responsible for originating and tracking all budgets, subcontractor contracts and schedules; 3) directs the Educator Ambassadors program; 4) contributes to the design and development of educational products and workshops for both students and teachers; and 5) is the main point of contact for the Science Mission Directorate Support Network, ensuring XMM-Newton participation in a wide variety of multi-mission activities.

The Education Resource Director, Dr. Phil Plait, is primarily responsible for science content development, having authored the E/PO website content, the student and teachers' manual for the CLEA laboratory, the script and teacher's manual for the Starlab, and portions of the

Supernova Educator Unit. He also implemented the simulations used in the CLEA lab to accurately represent X-ray spectra of a supernova remnant. He is responsible for ensuring standards alignment for the science and mathematics areas. He also conducts workshops for both students and teachers.

The Instructional Technology Expert, Tim Graves, was responsible for the design and implementation of the Starlab x-ray sky cylinder, and the construction, development, and operation of the SSU Pepperwood telescope. He also oversees the maintenance and support of all E/PO computer and server equipment.

Scientific Illustrator Aurore Simonnet is responsible for the design and layout of all graphical components of the XMM-Newton E/PO materials. She is creating a supernova poster, and will do the layout and illustration for the Supernova Educator Unit. She designed the graphics for the web site, the XMM-Newton ruler, and other printed materials.

The SSU group also employs a project assistant and student assistants to perform general office administration, including regular mailing to the Educator Ambassadors and E/PO network, general web administration and upkeep, ordering and receiving E/PO materials and other communications tasks.

Members of the XMM-Newton Guest Observer Facility Science team including Drs. Steve Snowden, Rich Mushotzky and Ilana Harrus are committed to providing oversight and input to the E/PO effort for XMM-Newton, ensuring the accuracy in the materials' content. They also speak to students and the public, and provide input into the design of the E/PO products.

External evaluation of the program is performed by WestEd, under the direction of Dr. Edward Britton. WestEd employs specialists in evaluating content in science, mathematics, technology, web site design and teacher training, and conducts implementation, formative and summative reviews of the XMM-Newton E/PO program.

Figure 1 – XMM-Newton E/PO Organization

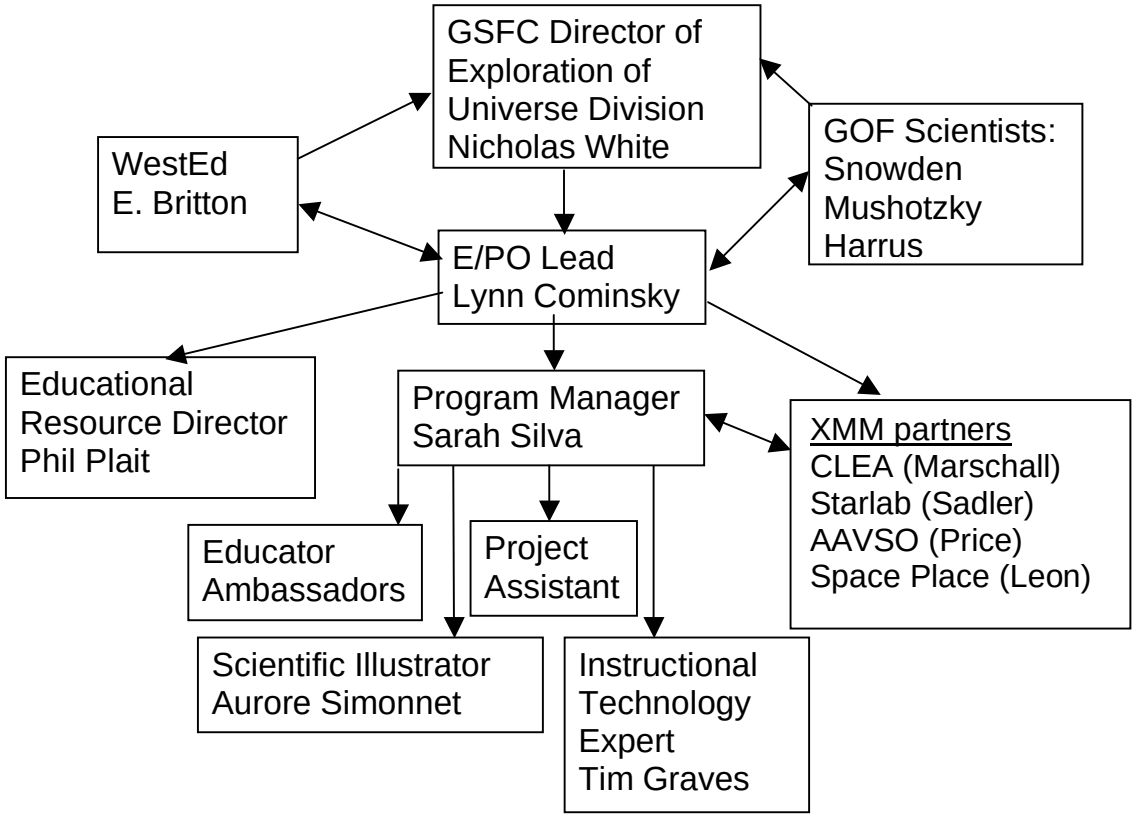

	Table 1 – XMM-Newton E/PO Goals	How do galaxies, stars, and planetary systems form and evolve?	What happens to space, time and matter at the edge of a black hole?	What are the cycles of matter & energy in the evolving universe?	
Science Goals	**E/PO Goals**	**Universe Division Goals**			**Program Components**
When and where are the chemical elements created?	Use x-ray observations of supernova remnants as an engagement to teach students about the relationship between the death of stars and the birth of the chemical elements	X		X	1.1 1.2 1.3 1.4
How does nature heat gas to X-ray emitting temperatures?	Use the map of the x-ray sky to illustrate the diversity of objects in the high-energy Universe, compare them to the visible sky and teach about the properties of different energies of light	X		X	1.1 1.5 1.6
What are the X-ray signatures of accreting black holes?	Use the engagement of black holes to develop science literacy for grades 4-12 and the general public		X		1.7

Table 2- XMM-Newton Evaluation Schedule

WestEd will conduct any or all of the following evaluation tasks for SSU-developed or SSU-sponsored classroom resources:

(i) Arrange and observe field-testing.
(ii) Arrange discussion via teleconferencing between SSU and teacher evaluators.
(iii) Expert appraisal of instructional design features as part of formative review.

These evaluation tasks will focus on the following materials:

E/PO Program Element	Material to be evaluated	Evaluator's Tasks
Fiscal Year 06		
1.7	Space Place Black Hole Game	(i), (ii)
1.2	CLEA lab	Effectiveness of materials dissemination
1.1	Educator Ambassador Program (summative)	(i), (iii)
Fiscal Year 05		
1.2	CLEA lab	(i), (ii), (iii)
1.3	XMM-Newton and GLAST Supernova Educator Unit	(i), (ii), (iii)
1.6	XMM Starlab Cylinder and Activities	(iii)
1.1	Educator Ambassador program and workshop follow-up (formative)	(i)
Fiscal Year 04		
1.1	Educator Ambassador Program (formative)	(i), (iii)
Fiscal Year 03		
1.4	XMM-Newton website at SSU	(iii)